Title: Transformations: Reflections, Translations, and Rotations

Course: Geometry (Mainly 9th and 10th Grade)

Objectives: Students will:
1. Identify and draw reflected images.
2. Recognize and draw lines of symmetry and points of symmetry.
3. Draw translated images using coordinates.
4. Draw translated images by using repeated reflections.
5. Draw rotated images using the angle of rotation.
6. Identify figures with rotational symmetry.

Reporting Categories: Transformations, Reflections, Translations, Rotations

Related SOL: G.2 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include
   a) ...
   b) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and
   c) determining whether a figure has been translated, reflected, or rotated.

Vocabulary: Transformation, Reflection, Line of Reflection, Isometry, Line of Symmetry, Point of Symmetry, Translation, Composition, Rotation, Center of Rotation, Angle of Rotation, Rotational Symmetry

Materials: Glencoe Mathematics Geometry textbook, paper, pencil, calculator (optional), graph paper, compass, ruler, protractor, colored pencils

Time Required: 90 minutes

Procedures:

- **Warm-Up Activities** (10 minutes)
  - Introduce the Transformations chapter with a class discussion about some of the terms that students might already be familiar with to get an idea about their prior knowledge.
    - Discuss their understandings of the following words:
      - Transformation: to change?
      - Reflection: mirror image? opposite image?
        - Line of reflection: like a mirror? Line you reflect over?
      - Rotation: to turn?
  - Wrap up this discussion with a formal definition of a transformation and discuss what we will be learning today.
    - Transformation: Operations that alter the form of a figure. The standard transformations are translations, reflections, dilations (stretches), compressions (contractions or shrinks), and rotations.
    - We will be learning about three specific types of transformations today: Reflections, Translations, and Rotations
Lesson Activities (45 minutes)
  o (5 minutes) Reflections
    ▪ Reflection: A transformation in which a geometric figure is reflected across a line, creating a mirror image. That line is called the line of reflection.
    ▪ Isometry: a congruence transformation; the image is congruent to the preimage
    ▪ Line of Symmetry: a fold that is a line of reflection such that, when folded on this line, the two halves match exactly
    ▪ Point of Symmetry: a point that is a common point of reflection for all points on a figure

Line of Symmetry is the dashed line. The top half of the arrow is folded over the line of symmetry such that it is identical to the bottom half of the arrow.

Line of Reflection is the solid line. The left arrow is reflected over the line of reflection onto the right arrow.

  o (10 minutes) Using Online Manipulatives: Reflections
    ▪ Go to http://nlvm.usu.edu/en/nav/category_g_4_t_3.html and click on Transformations-Reflection. Go through some of the activities found on the right hand side. Use this online resource to discuss reflection and corresponding rules in the following categories:
      • Reflecting a figure in a line.
        o Playing with Reflections
        o Hitting a Target

      • Reflection in the x-axis.
        o Describing Reflections
          ▪ Demonstrate more effectively with trapezoid.
        o Rules:
          ▪ Preimage → Image: \((a, b) \rightarrow (a, -b)\)
          ▪ How to find the coordinates: Multiply the y-coordinate by -1

      • Reflection in the y-axis.
        o Describing Reflections
          ▪ Demonstrate more effectively with trapezoid.
        o Rules:
          ▪ Preimage → Image: \((a, b) \rightarrow (-a, b)\)
          ▪ How to find the coordinates: Multiply the x-coordinate by -1

      • Reflection in the line y=x.
        o Describing Reflections
          ▪ Demonstrate more effectively with trapezoid.
        o Rules:
          ▪ Preimage → Image: \((a, b) \rightarrow (b, a)\)
          ▪ How to find the coordinates: Interchange the x- and y-coordinates
• Reflection in the origin.
  o Rules:
    ▪ Preimage \( \rightarrow \) Image: \((a,b) \rightarrow (-a,-b)\)
    ▪ How to find the coordinates: Multiply both coordinates by -1

  (5 minutes) Translations
  ▪ Translation: A transformation in which a graph or geometric figure is picked up and moved
to another location without any change in size or orientation.
  ▪ Composition: A transformation made up of successive transformations.

  (10 minutes) Using Online Manipulatives: Translations
  ▪ Go to [http://nlvm.usu.edu/en/nav/category_g_4_t_3.html](http://nlvm.usu.edu/en/nav/category_g_4_t_3.html) and click on Transformations-
  Translation. Go through the activities found on the right hand side. Use this online resource
to discuss translation and corresponding rules in the following categories:

  • Translations
    ▪ Playing with Translations
    ▪ Hitting a Target

  • Translations in the coordinate plane.
    ▪ Describing Translations
    ▪ \((x, y) \rightarrow (x+a, y+b)\)

  (5 minutes) Rotations
  ▪ Rotation: A transformation that turns a figure about a fixed point at a given angle and a
given direction.
  ▪ Center of Rotation: In a rotation, the point that does not move. The rest of the plane rotates
  around this one fixed point.
  ▪ Angle of Rotation: the angle through which a preimage is rotated
  ▪ Rotational Symmetry: exists when a preimage and its image are indistinguishable

  (10 minutes) Using Online Manipulatives: Rotations
  ▪ Go to [http://nlvm.usu.edu/en/nav/category_g_4_t_3.html](http://nlvm.usu.edu/en/nav/category_g_4_t_3.html) and click on Transformations-
  Rotation. Go through the activities found on the right hand side. Use this online resource to
discuss rotation and corresponding rules in the following categories:

  • Rotations
    ▪ Playing with Rotations
    ▪ Hitting a Target
    ▪ Describing Rotations
Guided Practice

Draw the lines of symmetry for the following figures:

- Drawing Assignment: Eventually for display in the classroom:
  - On a full piece of graph paper, draw a complex shape (not too big and NOT a circle, ellipse, parallelogram, or triangle).
  - Reflect it over the line $y=x$ (this is Image 1; shade it in with a new color).
  - Reflect Image 1 over the line $y=-x$ (this is Image 2; shade it in with a new color).
  - Translate Image 2 up 4, then right 2 (this is Image 3; shade it in with a new color).
  - Rotate the Image $90^\circ$ clockwise (this is the final image; shade it in with a new color).

- Closing Activities (5 minutes)
  - Have students turn in their classwork to put up on display in the classroom. If they are not done, they may take the drawing assignment home to finish for homework.
  - Assign the homework. If there is extra time, students may begin their homework during class.

- Evaluation:
  - Homework page 467-468, #25, 30, 32, 36, 40
  - page 473-474, #10, 16, 20, 27
  - page 479-480, #14, 22
  - Successful completion of the in-class drawing assignment.

Adaptations for Students with Special Needs:

- Have students work in cooperative learning groups on the warm-up.
- Fewer homework problems as needed.